

## SECTION 14 31 00

### ESCALATORS

#### PART 1 – GENERAL

##### 1.01 GENERAL DESCRIPTIONS

This Section includes requirements for Design, Fabrication, and Installation of Escalators to be installed on BART property.

- A. Trusses
- B. Drip Pans
- C. Step Drive Units
- D. Tracks
- E. Driving Machine and Motor
- F. Controller and Wiring
- G. Safety Device and Switches
- H. Brakes
- I. Steps
- J. Step Demarcation Lights
- K. Step Chains
- L. Rollers
- M. Comb Teeth
- N. Handrails and Handrail Drive Systems
- O. Landing Plates
- P. Balustrades
- Q. Skirt Panels
- R. Deck Covers and Moldings
- S. Remote Monitoring Systems
- T. Energy Efficient Motor Controller

## 1.02 RELATED SECTIONS

1. Section 05 05 22, Metal Welding
2. Section 05 12 00, Structural Steel Framing
3. Section 20 70 26, Common Materials and Methods for Electrical Systems

## 1.03 MEASUREMENT AND PAYMENT

### A. Measurement

1. Escalators will be measured for payment on a lump sum basis for all escalators.
2. All spare parts will be measured for payment on a lump sum for escalators spare parts.
3. Maintenance will be measured for payment on a per escalator per month basis. Maintenance shall include required updates of Operation and Maintenance Manuals.
4. Chargeable Repairs shall be based on approved maintenance reports and shall be paid under the Allowance for Chargeable repairs.
5. All other items of the Work of specified in this section will not be measured separately for payment, but will be considered incidental to the Work.

### B. Payment

1. Escalators, spare parts and Maintenance will be paid for at the contract unit and lump sum prices for quantities as determined by the measurement methods specified above.

## 1.04 REFERENCES

(Prevailing versions in effect at the time of contract signing shall apply to the work)

### A. American National Standards Institute (ANSI):

1. ANSI B18.12 Glossary of Terms for Mechanical Fasteners

### B. American Society of Mechanical Engineers (ASME):

1. ASME A17.1 Safety Code for Elevators and Escalators
2. ASME A17.2 Guide for Inspection of Elevators, Escalators, and Moving Walks
3. ASME A17.5 Elevator and Escalator Electrical Equipment
4. ASME B18.12 Glossary of Terms for Mechanical Fasteners

C. American Society of Civil Engineers (ASCE)

1. ASCE/SEI 7 Minimum Design Loads for Buildings and other structures

D. American Society for Testing and Materials (ASTM):

1. ASTM A123/A123M Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
2. ASTM A153/A153M Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
3. ASTM A385 Standard Practice for Providing High-Quality Zinc Coatings (Hot-Dip)
4. ASTM A653/A653M Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
5. ASTM A780 Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
6. ASTM A1008/A1008M Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable
7. ASTM B209 Specification for Aluminum and Aluminum-Alloy Sheet and Plate
8. ASTM B117 Standard Practice for Operating Salt Spray (Fog) Apparatus 10
9. ASTM B211 Specification for Aluminum and Aluminum-Alloy Rolled or Cold Finished Bar, Rod, and Wire
10. ASTM B221 Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rod, Wire, Profiles, and Tubes
11. ASTM B308/B308M Specification for Aluminum-Alloy 6061-T6 Standard Structural Profiles
12. ASTM B633 Specification for Electrodeposited Coatings of Zinc, on Iron and Steel
13. ASTM D412 Test Methods for Vulcanized Rubber and Thermoplastic Elastomers – Tension
14. ASTM D1149 Test Methods for Rubber Deterioration – Cracking in an Ozone Controlled Environment

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15. ASTM D2794      Testing Method for Resistance of Organic Coatings to the Effects of Rapid Deformation (Impact)
  16. ASTM E18      Standard Test Methods for Rockwell Hardness of Metallic Materials
  17. ASTM E84      Test Method for Surface Burning Characteristics of Building Materials
  18. ASTM E136      Test Method for Behavior of Materials in a Vertical Tube Furnace at 750 degrees Celsius
  19. ASTM E384      Standard Test Methods for Microindentation Hardness of Materials
  20. ASTM F593      Standard Specification for Stainless Steel Bolts, Hex Caps Screws, and Studs
  21. ASTM F594      Standard Specification for Stainless Steel Nuts
- E. American Welding Society (AWS):
1. AWS D1.1      Structural Welding Code - Steel
- F. American Bearing Manufacturers Association (ABMA):
1. ABMA STD 9      Load Ratings and Fatigue Life for Ball Bearings
  2. ABMA STD 11      Load Ratings and Fatigue Life for Roller Bearings
- G. Military Specifications (MIL)
1. MIL-P-21035      Paint High Zinc Dust Content, Galvanizing Repair (Metric)
- H. National Association of Architectural Metal Manufacturers (NAAMM):
1. AMP 503      Finishes for Stainless Steel
- I. National Electrical Manufacturers Association (NEMA):
1. NEMA AB 1      Molded-Case Circuit Breakers and Molded Case Switches, and Circuit-Breaker Enclosures
  2. NEMA PB 1      Panelboards
- J. National Fire Protection Association (NFPA):
1. NFPA 70      National Electrical Code
  2. NFPA 101      Life Safety Code

3. NFPA 130 Standard for Fixed Guideway Transit and Passenger Rail Systems

In case of conflict with ASME A17.1 requirements, A17.1 shall prevail.

K. Steel Structures Painting Council (SSPC):

1. SSPC-SP 3 Power Tool Cleaning
2. SSPC-SP 6 Commercial Blast Cleaning
3. SSPC-CS 23.00 Specification for the Application of Thermal Spray Coatings (Metallizing) of Aluminum, Zinc, and their Alloys and Composites for the Corrosion Protection of Steel

L. American Public Transit Association (APTA)

1. APTA RT-RP-FS-007-02

## 1.05 REGULATORY REQUIREMENTS

- A. In addition to the foregoing referenced standards, the regulatory requirements which govern escalator work of these Specifications include the following codes and regulations:
- B. California Code of Regulations (CCR):
  1. CCR Title 8, Industrial Relations.
  2. CCR Title 24, Part 2, California Building Code (CBC)
  3. CCR Title 24, Part 3, California Electrical Code
- C. California Occupational Safety and Health Act (CAL/OSHA)
- D. In the event of a conflict between codes, regulations, these specifications or standards, the most stringent requirement as determined by the Engineer shall take precedence unless specifically addressed herein.
- E. The requirement for CSA approval of electrical equipment as set forth in ANSI 17.5 will be waived by the District for any custom electrical equipment designed and manufactured specifically for this Contract.

## 1.06 DEFINITIONS

- A. Heavy-duty escalator: An escalator designed specifically for transit system usage, which is substantially different from commercial units in the design of truss, machine, step, step chain, step chain tensioning device, step, brake, handrail drive and other components/equipment.

- B. Working points: Points of intersection of step nosing lining and the horizontal of the top and bottom landing plates at finish elevation.
- C. Special tools: Tools designed specifically for tasks associated with escalator inspections, maintenance, and repair, or those which are required for these tasks and are not readily available through normal purchasing channels.
- D. Escalator support: These are the upper, lower and intermediate supports needed to support the total loads of the escalator.
- E. Slip joints: A slip joint is a sliding joint required to support escalators in a transit system and high rise applications. Location shall be at bottom support areas or as indicated on the Contract Drawings.
- F. Structural Rated Load: For the purpose of structural design, the rated load shall be considered to be not less than the weight of the escalator system plus the product of 320 pounds on each exposed step times the number of exposed steps.
- G. Machinery Rated Load: For the purpose of driving machine, power transmission and braking calculations, the rated load shall be considered to be not less than:  
  

$$\text{Machinery rated load (pounds)} = 6.0(W + 8)B \text{ (Approx. 320 lbs. per step)}$$

Where:     $W$  = width of the step tread (inches), to the next whole inch.

$$B = \sqrt{3} * \text{Total Escalator Rise (feet)}$$
- H. Other definitions as per APTA RT-EE-RP-001-02, Heavy-Duty Transportation System Escalators Design Guidelines.

## 1.07 QUALIFICATIONS

- A. Manufacturer's Qualifications: The escalator manufacturer shall have been a builder of heavy-duty transit type escalators regularly engaged in escalator building activity for at least the past five years. The design, engineering and manufacture of major escalator components such as truss, drive machine, steps, controllers, and safety devices shall be integrated and supplied by the escalator manufacturer of record , except where otherwise specified.
- B. Installers Qualifications: The Escalator shall be installed by a California Certified Qualified Conveyance Company and supervised by a CCCM.

## 1.08 DESIGN AND CONSTRUCTION REQUIREMENTS

- A. Escalators provided under the Contract shall be the product of the same Original Equipment Manufacturer (OEM). Design and construction requirements for the escalators shall meet at a minimum the requirements of the ASME A17.1 version in effect in California at the time of contract signing, except as specified herein, and as shown on the Contract Drawings.

- B. Escalators shall be heavy-duty type (as defined in APTA RT-EE-RP-001-02, Heavy-Duty Transportation System Escalator Design Guidelines), designed specifically for the operating, loading and environmental conditions encountered in extensively used, heavy-rail transit systems. Minimum design life shall be 25 years in use for 24 hours per day, seven days per week at the specified loading cycle.
- C. The document APTA RT-EE-RP-001-02, Heavy-Duty Transportation System Escalator Design Guidelines forms part of this specification. Where conflicts occur between the two documents, this specification shall prevail.
- D. Escalators installed outdoors shall be designed to operate while exposed to the natural elements of weather, at all conditions of relative humidity, while exposed to airborne dust, debris, and corrosive elements at a dry bulb temperature range of minus ten (-10) to plus one hundred and five (+105) degrees Fahrenheit. Escalators shall have pit drainage systems to accommodate the drainage of rainwater. Escalators installed indoors shall be designed to operate in a temperature range of plus five (+5) to plus 120 degrees Fahrenheit and have pit drainage systems to account for ground water and station wash-downs.
- E. Escalators shall be designed and fabricated to fit within the well-way dimensions shown on the architectural drawings.
- F. Escalators shall be designed to provide three flat steps at both the upper and lower ends.
- G. The preferred location of the drive mechanism is either in the upper pit or in a room below the upper pit under the incline of the escalator as per the station design. Locating the drive mechanism in the step band is strongly discouraged.
- H. The controller shall not be located within the escalator pit; it shall be located either in a room below the upper pit or below the truss incline, or in an exposed cabinet adjacent to the escalator at the top or bottom landing as per the station design. Where installed within an exposed cabinet location, cabinet shall be provided with lockable access doors, forced ventilation with filtered fans, and an internal heater. In such instances controller shall be designed to withstand high heat and humidity.
- I. Escalators shall be designed with provisions for thermal expansion and contraction of complete escalator assemblies due to changing ambient conditions.
- J. No wood products shall be permitted in the escalator system.
- K. Each escalator shall be of 48-inch nominal width measured at centerline of handrails and be designed for an incline of 30 degrees from horizontal plane.
- L. The drive mechanism, step drive unit assembly, steps, step linkage, comb plates, handrails, handrail drive units, and any parts subjected to wear or frequent removal shall be readily and easily removable and replaceable without requiring any modification or alteration of escalator structure, station structure, or equipment.
- M. On parts of equipment subject to wear and requiring periodic replacement, provide key and seat, nut, screws, or other removable and replaceable type mechanical

fasteners. Such replacements shall not diminish original structural integrity. Use of rivets or similar type fasteners requiring physical deformation during field positioning will not be permitted.

- N. Gaps and running openings within structural design tolerances where the escalator structure meets the surface of the finished openings shall be properly closed by the use of polyurethane sealant as specified or other approved means installed in accordance with the manufacturers' instructions.
- O. The equipment shall be quiet and smooth running and be capable of withstanding the operating conditions described herein.
- P. Surface irregularities, sharp edges, or protrusions in public and maintenance areas shall not be permitted.
- Q. Performance Requirements
  - 1. Hours of escalator operation shall be considered as 24 hours per day, seven days per week.
  - 2. Daily duty cycle shall be: three hours at 100 percent design load, six hours at 50 percent design load, and 15 hours at 25 percent design load.
  - 3. Direction of travel shall be Bi-directional, up or down and reversible.
  - 4. Speed: 100 feet per minute with 4 feet per minute maximum allowable speed variation under varying load conditions in either direction.
  - 5. Vibration: Vibration level shall not exceed 0.4 inches per second as tested using a Bruel and Kjaer Model 2516 integrating vibration meter or equal. Readings will be taken throughout the travel of the exposed steps.
  - 6. Variable Frequency Drive motor control a Hand/Auto/Off selector switch shall be provided to by-pass the variable frequency function.
  - 7. Escalators must be capable of remote emergency stopping due to fire alarm or seismic alarm condition.
- R. Seismic Design Criteria: The seismic design of the escalators, related supports and anchorages shall comply with CBC Section 1613, Earthquake Loads, and the referenced ASCE/SEI 7- Chapter 13, Seismic Design Requirements for Nonstructural Component, (Importance Factor,  $I_p=1.5$ ). In addition, the Safety Requirement for Seismic Risk Zone 2 or Greater, (Importance Factor,  $I=1.25$ ) and CCR Title 8 Section 3141.13(b), Seismic Requirements which references Section 3137(d) Seismic Requirements for Elevators, Escalators, and Moving Walks. The more stringent requirements among CBC, ASME A17.1, and CCR Title 8, Section 3141.13(b) shall govern.
- S. Airborne Noise Criteria: Maximum airborne noise shall not exceed 65 dBA measured at a distance of 48 inches above any moving step throughout the length of escalator travel and the immediate surrounding public areas.



T. Fire Protection:

1. Contractor shall provide escalators constructed of non-combustible materials throughout as defined in ASTM E136, with the exception of handrails, handrail rollers, chain step wheels, and electrical equipment. Handrails shall have a flame spread rating of 76 to 200, when tested in accordance with ASTM E84.
2. Fire protection shall comply with requirements as defined in ASME A17.1 and NFPA 130. In case of conflict A17.1 takes precedence. Coordinate with fire protection systems specified in Divisions 20 and 21.
3. Wellways shall be a continuous concrete or a continuous minimum 8 gage, galvanized steel construction with an oil water drip pan with side walls at least three feet high installed within a minimum two-hour rated construction on all sides.
4. Wiring used throughout the escalator installation shall be low smoke and halogen-free.
5. PVC shall not be used anywhere in the escalator installation.

U. Clearances:

1. Bottom escalator pits: There shall be a minimum working space of 36 inches between the step guard and the end of the escalator truss or any component along the pit wall, whichever is less.
2. Upper escalator pits: For escalators with the controller located in the machine room, there shall be a minimum working space of 36 inches between the step guard and the end of the escalator truss or any electrical component along the head pit wall, whichever is less. For dual motor drive escalators there shall be a minimum working space of 36 inches between the outside face of the drive motor/machine and the end of the escalator truss or any electrical component along the head pit wall, whichever is less.

**1.09 SUBMITTALS**

- A. General: Refer to Technical Specification Section 01 33 00, Submittal Procedures and Section 01 33 23, Shop Drawings, Product Data, and Samples for submittal requirements and procedures. All documentation shall have eight point or larger font, in English only.
- B. Shop Drawings: Submit shop drawings and data including the following for the Engineer's approval.
  1. Fully dimensioned, U.S. standard, (i.e. feet and inches) layout in plan and elevation views indicating component locations, structural supports, access spaces, and points of entry.
  2. Furnish reactions at the escalator truss supports and displacement of the escalator as determined from articles 1.08R and 2.04 herein to the Engineer.

3. Elevations and sections, manufacturing details of balustrades, deck, and skirt panels showing reinforcing jointing, anchorage, size, shape, and materials of each component, assembly details, finishes including push button fixtures, key switches, and required signage. Indicate direction of stainless steel directional grain.
4. Drawings showing the truss assembly, including materials, sizes and shapes of members, stanchions, reinforcing, connections, anchorages and supports, and attachment points for components. These drawings shall be stamped and signed by a currently licensed California Registered Civil or Structural Engineer.
5. Drawings for the truss, stanchion track system and supports, including drive chains and gear train; step chain or step links including chain pitch, step, and trailer wheels; reinforcing, jointing and anchorage; and size, shape, and materials of each component.
6. Drawings and technical data of the drive system, step drive system, handrail drive system, brake system.
7. Drawings and technical data for controller, and safety devices and switches.
8. Layout of electrical system including motor; control panel; disconnect switches; directional start and stop key switches; emergency stop switches and covers; light fixtures; receptacles, and control devices. Schematic diagrams including single line power diagram of the escalator system, control wiring diagram and sequence of operation, indicating interface connections with BART signal and control system. Contact count matrix to be included.
9. Provide complete schematics of all internal components and circuit boards, and wiring for external devices. Provide logic diagrams and application programming source code of controller. Show complete wiring diagrams with raceway types, sizes and conductor identification. Show nomenclature, full identification, and function of contacts. Documentation of software shall include programmer's notes and comments. Identify any and all functions and components.
10. Step chain details for material, configuration, arrangement, and lubrication requirements.
11. Step nosing radii at upper and lower ends;
12. Step assembly including axle, step tread, rollers, frame, and riser.
13. Safety brush material, mounting method and profile.
14. Copy of the grade of steel and heat treatment records.
15. Records showing chain lengths, measured under tension.
16. Hardness and case depth test results on representative samples of step chain pin outside diameter and bushing inside diameter surfaces after finish-grinding.

17. Superficial hardness test results per ASTM E 18 shall be used on Rockwell C scale.
18. Knoop 500 gram microhardness test per ASTM E 384 shall be used to determine case depth.
19. Rigging plan.
20. Method of installation of the escalator.

C. Product Data:

1. Manufacturer's design data and material specifications for all replacement parts and equipment. Specifications shall include test methods required to verify compliance with specifications.
2. Lubricants, sealants, paints and any other potentially hazardous substances shall be submitted for the Engineer's review. The Contractor shall submit the necessary Material Safety Data Sheets.

D. Operation and Maintenance Manuals: Submit Operation and Maintenance manuals in accordance with Section 01 78 23, Operation and Maintenance Data.

1. Drawings, installation and maintenance instructions, and other data pertinent to the components used in the escalator systems, including detailed repair data for all components, including disassembly and assembly of drive system, handrail drive assembly, and track system, inspection/gauging/torque requirements, inspection and testing schedules, reassembly, testing methods and other related information. Manuals shall cover all mechanical and electrical components, operating panels, controls and indicators.
2. Bill of Materials. For each escalator, submit an Indented Bill of Materials. The Bill of Materials shall be a list of all assemblies, subassemblies, components and individual parts of the escalator. Each assembly shall be broken into subassemblies, which shall be in turn broken into components, subcomponents, or individual parts. There shall be a full definition of the item to a degree sufficient to allow a mechanic to place an order for a replacement part, i.e. description of the item, manufacturer part number, BART Stock Number and quantity required. Individual assemblies, subassemblies, components, subcomponents, or individual parts, common to one or more escalator shall have the same identification throughout the system. The Indented Bill of Materials shall be prepared using a commonly available database or worksheet program, to permit sort on any field: for example, it shall be possible with simple searches of the database to identify all escalators where a selected subassembly is used, to identify all subassemblies in which a selected part is used, or to obtain a total count of a selected component.
3. Sample copies of preventive maintenance procedures and charts.
4. Provide manuals and supporting software documentation for any specialized tools as applicable.

5. Trouble shooting techniques.
  6. Complete detail drawings and wiring diagram of escalator fault finding device, source code and connection to annunciator panel.
  7. Procedures for adjusting brake, handrail tension, handrail chain drive tension, step chain tension, track system, and mechanical components.
  8. Instructions for removing floor plate, replacing comb components, removing and installing steps and interior panels.
  9. Control and schematic electrical wiring diagrams and source code of controller, including wiring of safety devices to connections with remote indication and control panels for each escalator and group of escalators.
  10. Electrical layout showing placement of lighting, light switches, receptacles, light fixtures, disconnect switches, and convenience outlets in machinery room, truss envelope, and pits.
  11. Substantial completion will not be granted until the Operation and Maintenance manual is accepted and delivered and the training is complete.
- E. Reliability and Maintainability Demonstration: Five copies of a reliability and maintainability demonstration report. Demonstrate and document compliance with reliability and maintainability requirements specified herein by means of (1) verifiable engineering analysis, (2) by static and dynamic testing, and (3) by analysis of field operational data. Submit the report 30 calendar Days after the completion of the escalator, and every 30 days thereafter. All reliability and maintainability documentation is subject to approval by the Engineer.
- F. Failure Mode and Effects Analysis: Provide five copies of a Failure Mode and Effects Analysis for all escalator safety circuits and components, including but not limited to steps, brakes and step and axle rollers and any other components which could affect rider safety.
- G. Structural Calculations: Submit structural details and calculations for the truss assembly as specified herein Article 2.04 and seismic design as specified herein Article 1.08. The structural details and calculations shall be stamped and signed by a currently licensed California Registered Civil or Structural Engineer.
- H. Samples: Provide one sample of each of the following:
1. Handrail (two-foot section).
  2. Step assembly including wheels, tread plate, and step demarcation.
  3. Skirt panel: 12 inch by 12 inch minimum, including fasteners and trim.
  4. Balustrade Panel: 12 inch by 12 inch minimum, including fasteners.
  5. Comb plate and comb segment.

6. Demarcation light fixture.
  7. Pit lighting fixture.
  8. Safety switches.
  9. Key switches.
  10. Emergency Stop Button assembly with cover and alarm switch.
  11. Two sets of six links including pin of the following chains:
    - a. Main drive chain.
    - b. Handrail drive chain.
    - c. Step chain with rollers.
  12. Anti-slide device.
  13. Landing plate, full width.
  14. Safety brush, 12 inches long.
- I. Certification: For each lot or load of all chains and handrails delivered to the jobsite, furnish manufacturer's affidavits or test reports of compliance or similar certification acceptable to the Engineer, certifying that the material complies with the escalator manufacturer's specification requirements.
- J. Submit a Training Development Plan for approval.
- K. Submit a Test Program for approval with a test schedule and test procedure formats for every representative type of test that is to be scheduled. Refer to Field Quality Control specified herein for testing requirements.
- L. Other drawing requirements and samples are specified in appropriate articles of this specification section.
- M. Electrical Calculations: For each escalator, submit for approval:
1. Power system calculations signed by a currently licensed California Registered Professional Engineer for the main feeder circuit for operation at the Machinery Rated Load and for the escalator starting condition.
  2. Electrical/Mechanical calculations for the sizing of driving machine, motor and brake.
- N. Brake Calculations: For each escalator, submit detailed calculations for the brake, including calculations of braking distance and deceleration rate per prevailing ASME A17.1 for all loads from no load to the Machinery Rated Load, and for up and down directions.
- O. Submit heat release calculations for machine room and controller enclosures.

- P. Welders Certificates: Per AWS D.1.1 or Engineer approved equal.
- Q. List of service prices for chargeable repairs.
- R. As-built Drawings: Submit as-built drawings including the following for Engineer's approval.
  - 1. Truss stanchion
  - 2. Track System and supports
  - 3. Drive system
  - 4. Step nosing radius upper and lower ends
  - 5. Drive chains and gear train
  - 6. Step chain or step links including chain pitch, step, and trailer wheels
  - 7. Step assembly including axle, step tread, and frame and riser
  - 8. Handrail system including profile, guides, and drive and tension device
  - 9. Support details balustrade deck cover, interior panels, and skirt panels and moldings
  - 10. Safety switches and operating devices
  - 11. Motor and emergency brakes
  - 12. Floor plates
  - 13. Speed governor
  - 14. Metal gauges
  - 15. Radial vertical, and horizontal dimensions required for manufacturer and positions of lower and upper working points
  - 16. Attachment of truss to structure
  - 17. Major mechanical and electrical components within the truss
  - 18. Drainage and electrical interfaces
  - 19. Hand and finger guards
  - 20. Ceiling intersection guards
  - 21. Passenger instruction signs
  - 22. Emergency stop button

23. Operating panel in upper and lower balustrades

**1.10 FACTORY VISIT**

- A. Provide schedule of construction, assembly, and testing of major components at the factory or assembly plant.
- B. The contractor shall arrange for the District's representatives to visit the factory where the escalator is being manufactured to test the operation. The travel costs for such visit will be paid by the District.
- C. The escalator shall be tested at the factory with the controller to be shipped with the escalator. The District will observe the steps and chain in operation and test selected devices.
- D. The installer shall not ship the escalator without the approval of the District after the conclusion of the factory visit.
- E. The escalators shall not be shipped without the District's approval upon conclusion of the factory visit and tests.

**1.11 SPARE PARTS**

- A. General: Spare Parts shall be provided in accordance with Section 01 78 44, Spare Parts and Maintenance Materials, as augmented by the following provisions.
- B. Spare parts shall become the District's property and shall not be used by the Contractor for maintenance.
- C. A "set" is the number of parts required per escalator.
- D. Recommended Spare Parts List: Submit for approval a List of recommended spare parts necessary to support maintenance for a period of two years. The Engineer will review the List, assign a BART Stock Number to each item and return the List to the Contractor. The Contractor shall incorporate the BART Stock Number and resubmit the List, together with two additional sets of bar code labels to the District, prior to the acceptance of the escalator.
- E. Required Spare Parts. The Contractor shall supply as a minimum the following spare parts, plus any additional parts identified by the approved Spare Part list.
  - 1. Comb sections: Two Complete sets per escalator.
  - 2. Steps: Ten complete steps per escalator.
  - 3. One complete set of step chain for each size/type/model escalator supplied.
  - 4. Handrail drive: One complete assembly for each escalator supplied (left and right) including, but not limited to, gears/chains, sprockets, and wheels.
  - 5. Chain rollers: Two complete sets per axle per escalator.

6. Step rollers: Two complete sets per step per escalator.
  7. Brakes: One complete set of all brake assemblies required for each size escalator supplied.
  8. Demarcation fixture and ballast: Two complete sets per escalator.
  9. Switches (micro/safety) & sensors: One complete set of all switches and sensors.
  10. Fuses: Two of each size.
  11. Printed circuit board or Programmable Logic controller (PLC) (Plug-in or hardwire); One for each type used.
  12. Start switch/stop button assembly: One set per escalator.
- F. Delivery: Notify the Engineer in writing 72 hours prior to any delivery. The notification shall identify the specific parts to be delivered. All spare parts shall be delivered no later than 30 calendar Days prior to the final acceptance of the escalator.
- G. Spare parts shall be properly packaged so as to prevent damage during shipment and long term storage.

#### **1.12 PERMITS**

Refer to General Conditions Article 7.4, Permits and Licenses, for the Contractor's responsibility to obtain and pay for any and all necessary permits including and not limited to permit to complete and operating permits. The Contractor shall arrange and pay for inspections by governing authorities and obtain operating permits required until final completion of the contract. Contractor shall submit required drawings and design calculations to the State and a copy to the Engineer.

#### **1.13 SPECIAL TOOLS**

- A. Deliver special wrenches, tools, and keys to the Engineer at the completion of each escalator, including but not limited to: all tooling required to attach a torque wrench to the drive machine used to accurately measure the brake torque, and a "Set" of tooling required to remove steps.
- B. Deliver three complete sets of keys to operate each different type of key operated switch and lock.
- C. Label each special wrench, tool, and key with an approved plastic or metal label tag. Labels shall be engraved to identify tool. For keys, provide each key and its tag on a small ring.
- D. Deliver four hooks and/or T-Handles, required to remove floor plates.



## 1.14 MAINTENANCE

- A. Maintenance Program: Within 90 Days after the Notice-To-Proceed, and prior to installation, Contractor shall submit a detailed maintenance program, showing functions to be performed and their schedule. The maintenance program shall include preventative maintenance, trouble call service and emergency repair service during the Maintenance Period. The maintenance program shall also include all work and materials needed to keep the equipment in perfect operating condition. Contractor shall coordinate and perform maintenance in a manner to result in minimum inconvenience to the public.
- B. Maintenance Period:
  1. Contractor shall perform preventive maintenance and any repairs on the escalator due to equipment failure for a period of 12 months after Substantial Completion is granted and the unit opened for public use. During the Maintenance Period, Contractor shall provide complete preventive and corrective maintenance on all components and assemblies of the escalator. At the end of the 12 months Maintenance Period, the District may extend the maintenance period by and additional two (2) years. If the District exercises this option, the Contractor will be compensated in accordance with the corresponding bid schedule line item. The District reserves the right to terminate the Maintenance Period at any time, upon giving 30 Days' notice to the Contractor. Contractor will not be relieved of maintenance until Relief from Maintenance is granted by the District.
  2. Maintenance service shall not be subcontracted but shall be performed by or supervised by the Contractor's qualified CCCM personnel.
  3. Maintenance shall include all labor and materials needed to achieve and maintain minimum 96 percent reliability for the equipment. Contractor shall coordinate and perform maintenance in a manner to result in minimum inconvenience to the public.
  4. At the completion of the Maintenance Period, the equipment shall receive a final inspection performed jointly by the Contractor and the District representative. All discrepancies identified shall be corrected at no additional cost to the District. The term of the Maintenance Period shall be extended to provide sufficient time required to clear all identified discrepancies as approved by the Engineer at no additional cost to the District.
  5. The maintenance service will not be required to cover adjustments, repairs, or replacement parts due to misuse, abuse, or vandalism.
  6. The Contractor shall maintain local inventory of all wearing parts of the escalator system. Only genuine OEM parts and supplies used in manufacturer and installation of the original equipment shall be provided.
  7. Contractor shall obtain written approval from the BART administrator prior to replacing parts.

8. Contractor shall provide and maintain up-to-date complete list of personnel who access the District assets. The list shall include names and 24-hour contact information, including telephone numbers.

C. Trouble calls during maintenance period

1. For any trouble calls, the District will notify the Contractor of the incident. The Contractor shall be on site within four hours. The Contractor shall notify the designated BART Elevator/Escalator Maintenance representative upon arrival to the site, and check out upon completion of the trouble call. BART personnel may observe the repairs or adjustments made by the Contractor's personnel.

D. Escalator Access:

1. For routine maintenance, the Contractor shall request access to the escalator and coordinate access with the BART elevator/escalator maintenance department representative.

E. Work Hours for Maintenance:

1. Repairs required to return equipment to service shall be accomplished as soon as possible during revenue and non-revenue hours.
2. Routine maintenance, non-urgent repairs, and warranty work shall be performed on no more than one escalator at a time at a station. Routine maintenance shall not be performed during revenue peak hours. Routine maintenance may also be performed during non-revenue hours. Refer to the Contract Specifications for a definition of revenue peak hours and non-revenue hours for the station.

F. Inspection during the Maintenance Period:

1. The Contractor shall perform systematic inspection every two weeks, which shall include adjustment and lubrication of escalator equipment as required by the manufacturer. Replace defective parts with new parts of same manufacture as required.
2. There will be an annual permit inspection scheduled by and at the expense of the District.
3. BART will monitor Contractor's work by whatever means are deemed necessary, including employing others to inspect and/or test the equipment condition and the maintenance work quality.

G. Escalator Shutdowns:

1. Should an escalator become inoperative, the Contractor's service representative shall physically attend to the escalator within four hours of notification of a failure. If the failure occurs after 8:00 PM, the service representative shall be on-site no later than 7:30 AM the following Day. This schedule shall apply seven days per week, 52 weeks per year. The escalator shall be returned to service as quickly as possible.

2. Should there be a failure to comply with the above response time requirements a penalty of \$500 shall be assessed for each hour delay.

H. Final Service and Inspection:

1. Two weeks before expiration of the Maintenance Period, the equipment shall be lubricated, fully serviced, adjusted to the standards designated herein and safety devices shall be checked; Contractor shall re-lamp the escalator demarcation light fixture and the pit light fixtures. A complete inspection will be performed jointly by the Engineer or District representative and Contractor's representative. A comb impact test and a no- load brake tests in accordance with Article 3.03, Field Quality Control, herein shall be performed by the Contractor. If these tests demonstrate any non-compliance with the specifications, the Contractor shall perform the full battery of brake tests until the escalator is in full compliance. Each test shall be approved by the Engineer.
- I. Contractor will not be responsible for cleaning and repair of balustrades, cladding, or decking, unless repair is necessary and performed due to defective materials or improper installation. Contractor shall be responsible for cleaning of oil and grease residue as well as any debris resulting from their maintenance or repair activity.
- J. The contractor's technicians responding to trouble calls or performing Preventive Maintenance shall contact the designated BART Elevator/Escalator Maintenance representative and provide the following information: worker's name, date, arrival time, total time spent on site, parts inspected, adjustments made, parts replaced, and detailed description of the work done.
- K. A work log on each escalator shall be maintained at the escalator location, providing information on date and time of the visit, worker's name, date, arrival time, total time spent, parts inspected, adjustments made, parts replaced, and detailed description of the work done. The work logs will be regularly reviewed by the Engineer.
- L. Chargeable Repairs: Contractor will not be responsible for the cost associated with trouble calls that are due to misuse, or accidents, or are otherwise not caused by the Contractor. Calls which result in adjustment of safety devices not accessible to the public will not be reimbursed. Contractor shall submit all documentation necessary to prove that a particular trouble call should be a Chargeable Repair. Contractor shall submit all documentation necessary to justify the direct costs incurred for chargeable repairs and detail charges in accordance with the schedule of service prices submitted and approved by the Engineer prior to the start of the maintenance period.

**1.15 RELIABILITY:**

A. Definitions:

1. Break-in Period: The initial period of operation of the escalator. There shall be only one break-in period for the escalator, regardless of maintenance, unless a modification or other major work done has been performed on the escalator, during, or after the break-in period.

2. Failure: An incident which is corrected by replacing a part, resetting the unit, or making an adjustment. Exceptions to failure are conditions of misuse, vandalism, accidents or negligence not caused by the Contractor.
3. Incident: An incident is any escalator stoppage, regardless of cause.
4. Pattern Failures: The occurrence of multiple independent failures of the same primary replaceable item or adjustment in identical or equivalent applications.
5. Reliability Demonstration Test (RDT): A test to determine a reliability-associated parameter, such as available operating time, within defined statistical risks or with a specific statistical confidence.

B. Requirements:

1. The Break-in Period shall begin after the installer has satisfactorily completed the escalator installation, obtained State operating permits and the Engineer has performed and approved substantial inspection of the escalator. The escalator shall be barricaded and operated continuously under no load condition for a minimum of 48 hours. Upon a continuous, 48-hour operation without incident, the barricades may be removed and the escalator may be put into service to be used by the public.
2. After the Break-in Period, the Reliability Demonstration Test (RDT) shall begin. The escalator shall operate up to full load under normal modes of operation in either direction and be able to provide minimum 96 percent reliability as determined by the following formula:

$$\text{Percent Reliability} = T/A$$

T = Actual aggregate operation time for the escalator. Downtime for scheduled preventative maintenance and incidents, which are not failures, shall not be deducted from the aggregate operation time.

A = Aggregate revenue operating time of the respective BART station, nominally 20 hours per day.

3. Contractor shall take corrective action to eliminate pattern failures, regardless of total operating time accumulated. The Contractor shall notify the District's Engineer or designated elevator/escalator maintenance representative that an escalator undergoing corrective maintenance is ready to be returned to service to ensure appropriate time tracking for the purpose of accurately tracking the reliability percentage by using the formula above. Failure by the Contractor to report "returned to service" will result in lower reliability performance and will remain the responsibility of the Contractor.

C. The Contractor shall:

1. Collect the data and document the results of the RDT, perform all calculations, and issue the results.

2. Review all failure incident reports to ensure that only pertinent failures are included in the test results.
  3. Review the data with District at interim stages of the RDT and at the final stage, prior to issuing the results.
- D. If the District determines that the RDT has fallen below the 96 percent goal for any consecutive 30 Day period, the Maintenance fee due to the Contractor for that 30 Day pay period shall be reduced by the following formula:
- $A = MF * \text{Percent Reliability}$
- A = Amount due to Contractor
- MF = Monthly Maintenance Fee for one escalator.
- Percent Reliability = As calculated above.
- Prepare and submit reliability and maintainability report per Article 1.09.E.

## 1.16 REPORTING

- A. The Contractor shall submit to the BART administrator monthly service records, including repair work reports, call out reports, and semi-annual inspection reports for each escalator. The reports shall contain the details of each maintenance and repair activity including at a minimum the following:
1. Equipment ID.
  2. Date.
  3. Time on site.
  4. Location.
  5. Crew size.
  6. Work duration.
  7. Description of the work performed.
  8. Parts replaced.
  9. Cause of the shutdown and the resolution of the same.
- B. The records are required to be submitted with the invoice package and are required for payment processing.

## PART 2 – PRODUCTS

### 2.01 GENERAL

- A. Each escalator shall be a self-contained, heavy-duty transit unit as defined by APTA RT-EE-RP-001-02 consisting of truss, tracks, step drive units, steps, step chains, comb plates, handrails, driving machine, controller, safety devices, balustrades, cladding and all other parts required to provide a complete operating installation. The design and method of installation of each escalator shall be such that each will operate within the tolerances specified herein. Installation shall allow items in machine space to be removed with portable hoist or other approved means for replacement or repair.
- B. Each escalator assembly shall meet the requirements of CCR Title 8, CCR Title 24, Part 2 and 3, ASME A17.1, A17.2, ANSI A17.5 and NFPA 70 and 101.
- C. Each escalator shall be of the cleat step, reversible type with full semicircular extended newels and handrails. Each escalator shall be capable of operating and stopping under full load condition in either direction for ascending or descending transportation service.
- D. Weatherproofing: All ferrous, non-stainless steel metal surfaces shall be hot-dipped galvanized, spray on zinc coated, or powder coated as approved by the Engineer. Machined and operational areas shall be protected from corrosion by applying a rust preventative compound, plastic foils, oil or grease. Electrical enclosures shall be NEMA 4 or 4X, stainless steel enclosures and penetrations, raceways and wiring shall be waterproof. Wiring shall be in galvanized rigid minimum three fourths of an inch steel conduit along the incline portion of the truss and within the upper and lower pit spaces except where otherwise noted. Flexible conduit (NEMA 4 rated and provided with an internal galvanized flex core with a liquid tight protective outer cover) can be used to obtain the necessary bending radii to get to switches and sensors. Decking, balustrades, and cladding shall have smooth and tight fitting seams to prevent rainwater from entering the escalator truss.
- E. Lubrication System Requirements
  - 1. All parts, other than sealed bearings, requiring lubrication shall be designed for an automatic or remote lubricating system. The lubrication system shall operate only when the escalator is running and the amount of lubrication shall be fully adjustable. A reservoir shall be provided with a low oil signal to the controller, and a minimum capacity sufficient for one month of operation without refill.
  - 2. The lubrication system shall be positive acting and located in the escalator pit to allow for easy access.
  - 3. Reservoir level indications shall be provided and visible where lubricants are contained within housings, supply tanks, and large filler cups.
  - 4. Contractor shall furnish and mount near the lubricating system in the escalator pit, a framed lubrication chart for each escalator. The chart shall show the

location of each lubrication point, type of lubricant to be used, and the frequency of lubrication.

5. All tubing shall be supported to truss structural members using clamps or other approved support method.

F. Bearings

1. All bearings shall be ball or roller bearings rated for severe, heavy-duty service, 200,000 hours L10 life.
2. Bearings shall be pre-lubricated by the bearing manufacturer for the life of the bearing.
3. Bearing manufacturer shall be ISO 9000 series certified.

G. Oil collector chutes and collection trays shall be fabricated galvanized or stainless steel, shall be watertight and shall be free of obstructions for ease of cleaning.

H. Fasteners – All fasteners shall conform to the following:

1. Fasteners exposed to view to the public shall be stainless steel as specified herein.
2. Truss structure bolts shall be galvanized steel as specified herein.
3. All fasteners required to be removed for routine maintenance as defined by the manufacturer's own maintenance manual shall be stainless steel as specified herein. At a minimum, the following fasteners shall be stainless steel:
  - a. Floor plate supporting hardware.
  - b. Handrail tension device, mounting and adjusting hardware; friction belt roller mounting and spring plate adjusting mountings; handrail drive shaft flanged pillow block mountings and adjustment slotted fastenings, and all adjusting hardware.
  - c. All handrail support roller mountings.
  - d. Mounting hardware for the service brake solenoid, brake band, all switches mounted on the end of the motor-mechanical blocking device switch and flywheel mounting hardware.
  - e. Safety brake solenoid mounting hardware.
  - f. Slack drive chain switch mounting hardware.
  - g. All safety switch and proximity device mounting hardware.
  - h. All mountings, fastenings, and adjusting hardware on the comb plate and comb impact devices.
  - i. Step band guard mountings.

- j. Handrail drive chain tensioning assembly, adjusting fasteners, and mounting fasteners.
  - k. Handrail rupture safety device mountings.
  - l. Handrail entry fastenings for inner and outer plates and handrail rubber collar mountings.
  - m. Skirt panel mounting fasteners, splice brackets, skirt switch mounting bracket fasteners.
  - n. Handrail decking joints, mountings, and fastenings.
  - o. Balustrade panel studs and trim mountings.
  - p. Electrical junction boxes within the pits and truss, and the mounting hardware for anything housed within these boxes such as DIN rail mountings and switch and device fastenings.
4. All other fasteners shall be equal to or of greater corrosion resistance than the most corrosion resistant metals being fastened.

## 2.02 MATERIALS

- A. Sheet Steel: ASTM A1008/A1008M, uncoated, pickled.
- B. Sound Deadener: Vibradamp Corporation's No. 111, 3M's Coating ED-1000, Presstite's No. 105A, or equal; asphaltic based compound for spray application; black.
- C. Stainless Steel: Type 316, unless Type 316 does not exist for a particular item or shape, then Type 304, NAAMM AMP 503 No. 4 finish where exposed.
- D. Structural Steel: Shall conform to Section 05 12 00, Structural Steel Framing.
- E. Fasteners:
  - 1. Externally threaded steel fasteners shall conform to SAE J429, Grade 5.
  - 2. Steel Nuts (other than locknuts) shall conform to SAE J995, Grade 5 or ASTM A563 Grade B.
  - 3. Locknuts shall conform to IFI 100/107 "Prevailing-Torque Type Steel Hex and Hex Flange Nuts," Grades B. Also, non-metallic (nylon) top insert locknuts conforming to ASTM B18.16.6-2008 grades NE5 are acceptable.
  - 4. Stainless steel externally threaded fasteners shall conform to ASTM F593. Stainless steel nuts shall conform to ASTM F594. Stainless steel material shall be Group 1, Alloy 304 or equal, condition CW.
- F. Aluminum: ASTM B211, B221 and B308/B308M. 6061 or alloy and temper best suited for anodizing finish specified.



- G. Aluminum Sheet or Plate: ASTM B209, 6061 alloy, T651 temper.

## 2.03 FINISHES

- A. Exposed-to-View Surfaces:

- 1. Sheet Steel:

- a. Shop Prime: Clean of foreign substances and apply one coat of zinc chromatic or similar primer compatible with finish paint specified.
  - b. Finish Paint: Three coats enamel in accordance with paint schedule; sand each coat smooth; color as selected by the Engineer.
  - c. Powder coating is allowed in lieu of primer and paint and shall be tested per ASTM B117 and D2794.
- 2. Stainless Steel: Plain: Satin directional grain, NAAMM AMP No. 4 finish, #180 grit or finer, unless otherwise specified. Sanding medium shall not deposit particles in the grain that are capable of rusting.

- B. Paint and Corrosion Protection: The escalator shall have the following minimum corrosion protection:

- 1. All ferrous metal parts of the escalator, including cast metal parts such as gear housings, chain sprockets, and return station sprockets that are not stainless steel or galvanized, shall be prepared in accordance with SSPC SP-6 and shall be primed with a rust-inhibitive primer and painted or otherwise protected as approved by the Engineer. Paint finish coats shall be as follows:
  - a. Two heavy-duty gloss enamel, minimum two mil (dry film thickness) each coat.
- 2. After welding, the truss shall be hot-dipped galvanized with a coating in accordance with ASTM A123, or coated with 100 percent zinc thermal spray complying with AWS C 2.23M/C2.23, NACE No. 12, SSPC-CS 23.00 and applied in accordance with ANSI/AWS National Standard for application of thermal coatings.
- 3. Galvanizing
  - a. Sheet Steel thicker than 10 gage; ASTM A653, as applicable. Coating designation G185.
  - b. Other galvanizing: ASTM A123, A153 or A385, as applicable.
  - c. Galvanizing Touch-up: Zinc coating: MIL-P-21035.
- 4. Powder coating is allowed in lieu of primer and paint and shall be tested per ASTM B117 and D2794.

- C. Steel Fasteners. Except for stainless steel, steel fasteners shall be zinc plated per ASTM B633 Fe/Zn, Class 5, Type III, colorless chromate treatment.

## 2.04 TRUSSES

### A. General

1. The trusses shall span the distance between the support points as indicated. The working points as indicated shall not be moved except as approved by the Engineer.
2. Trusses shall be sufficient width to accommodate the width of the finished escalator.
3. Trusses shall be designed to rest on the available truss supports, and/or existing supports in each facility.
4. Trusses shall be of ample strength to maintain alignment of tracks and moving parts, and so designed that they shall safely retain steps and running gear, and in case of failure of track systems, retain step mechanism within guides and envelope of the truss.
5. The truss shall be designed to applicable AISC standards referenced in Section 05 12 00, Structural Steel Framing to support the Structural Rated Load.
6. The vertical deflection of the loaded trusses shall not exceed one one-thousandths (1/1000) of the free supporting distance of not less than 50 feet. Deflection shall be measured at the midpoint between the support points from the position of the unloaded truss to the position of the truss with the fully installed escalator loaded at the Structural Rated Load.
7. Truss material and fabrication shall conform to Section 05 12 00, Structural Steel Framing, and Section 05 05 22, Metal Welding.
8. Holes for attaching components shall be drilled or punched prior to galvanizing truss.

### B. Field Modifications, Connections, and Shims.

1. Field splices shall be rigid non-deforming, and shall maintain alignment.
2. Field modification by burning shall not be permitted.
3. Field modification shall not compromise paint and corrosion protection.
4. All shims shall be stainless steel, Type 316.
5. Support shims shall not exceed two inches.

### C. Structural Requirements:

1. The installer shall provide escalator truss mounting angles and intermediate truss supports with attachments, sized as required to install escalators into well-way structural support system shown on the Contract Drawings.

2. Escalator intermediate support points shall be provided by the installer where indicated on Contract Drawings. Reaction loads, and calculations shall be signed by a Civil or Structural Engineer, licensed in the state of California, and submitted by the escalator installer for approval by the Engineer.
3. Seismic calculations shall be based on the ATPT design loadings in this document.

## **2.05 DRIP PANS**

- A. Provide for each escalator, a drip pan of sufficient size to collect oil and grease from step linkage, rainwater, and all forms of loose debris that may be deposited into the escalator truss. The drip pan sidewalls shall have a minimum height of three inches at the top pit and incline section and a minimum height of four inches at the bottom pit. At the upper section of the truss, the drip pan shall be sloped so that all liquids collected drain towards the lower section of the truss. At the lower section of the truss, the drip pan shall be constructed so that the liquids collected drain from anywhere in the truss towards a drain in the drip pan. Drip pan construction shall prevent oil from leaking below the truss. The drip pan shall flow into a catch basin under the truss that is connected to the industrial waste line of the station or as indicated on the Contract Drawings.
- B. Drip pan shall be of watertight, minimum eight gauge, galvanized sheet steel construction over the entire length and width of the truss and under the machine and pit spaces. All joints between the sheets making up the drip pan shall be sealed over the entire length of the joint. Pan shall be hot-dipped galvanized after all welding, drilling, and tapping have been completed. 100 percent zinc thermal coating per AWS C 2.23 M/C 2.23, NACE No. 12, SSPC-CS 23.00 is also acceptable as approved by the Engineer. The drip pan shall be capable of supporting 150 pounds per square foot and 500 pounds concentrated load. Drip pan shall have a removable drain plug located at the lowest end. Drip pan shall be mounted within the truss members and shall be free of obstructions to permit flow of liquids and small debris and to facilitate clean up. Brackets or other obstructions shall not be fastened to the inside of the drip pan.
- C. An access hatch, 18 inches in diameter, shall be located in the drip pan at the lower landing, directly above the escalator pit drain for the purpose of cleaning the drain catch basin. The hatch shall be of same material and shall be designed to support 150 pounds per square foot.
- D. Prevent the splatter of chain or gear oil beyond the escalator truss and drip pan.
- E. Any water intrusion at the top and bottom of the escalator, shall be prevented from entering the well-way and directed to drain into the truss drip pan.

## **2.06 STEP DRIVE UNITS**

- A. The step drive unit shall be designed for heavy-duty transit escalator service and be mounted and supported within the truss envelope at the upper end.

- B. Escalator Drive Equipment shall be readily accessible for inspection, servicing, and replacing of equipment.
- C. Carriage Requirements: Carriage for tensioning step chain shall move on tracks. Such movement shall be accomplished by use of precision ground rollers or slides and horizontal guides to prevent skewing while adjusting carriage.

## **2.07 TRACKS**

- A. Design and fabrication of tracks shall retain steps and running gear safely under load requirements and at the highest design speeds specified.
- B. Contractor shall assemble and secure sections of track together for easy removal and replacement of defective sections. The system shall be adjustable, and welding of the tracks is not acceptable.
- C. Design of the mechanical components shall provide for easy installation and removal without the dismantling of parts of the structure.
- D. Tracks shall be properly supported on trusses to provide correct alignment and smooth transition to return stations. The rolling surface of the track shall be a minimum thickness of 0.13 inch.
- E. The track system shall be smooth for continuous support of the chain wheels from sprocket to sprocket. The transition between incline and upper landing level shall be accomplished by a curved track system with a minimum of 102 inches radius; the transition between incline and lower landing level shall have a minimum of 79 inches radius.
- F. The guiding system for the step chains and step wheels shall be of hot-dipped galvanized steel profiles with smooth and even running surfaces, and with the joints cut diagonally to the running direction.
- G. A second, continuous guiding profile shall be provided above the step chain rollers so that the step chains are positively guided in the area of the escalator open to passengers.

## **2.08 DRIVING MACHINE AND MOTOR**

- A. Machine shall be readily accessible without use of special tools. The motor shall be flange mounted directly to the driving mechanism. Worm or helical gears may be employed.
- B. Motor shall be fan cooled and have a service factor of 1.15 and have insulation group B. Motor shall be a variable frequency drive (VFD), AC induction motor and shall operate at 480 Volts, 3 phase, 60 Hertz power. Motor shall be rated for minimum 90 starts per hour, and be designed and built specifically for escalator applications.

- C. V-belt drives are not acceptable. If chain drives are used, they shall be protected against dirt and water by sealed housings, and shall have an automatic lubricating device and an adjustable means of taking up any slack in the chain.
- D. The driving machine shall be designed to operate continuously for the Machinery Rated Load.
- E. All motor encoders and speed sensors shall be capable of bypassing or disabling, forced underspeed, overspeed, and reversal. Any encoder, speed sensor etc. shall be of the heavy-duty type, and covered as approved by the Engineer.
- F. Gear Box Requirements:
  - 1. Gear bearings shall be rated with an ABMA L10 life of 200,000 hours and housed in an oil tight, dust proof case. The case shall provide a convenient method of draining the oil.
  - 2. Use synthetic lubricants, subject to Owner approval.
  - 3. Rotating parts shall be provided with the means for lubrication and retention of lubricants.
  - 4. Sealing bearing shall be used.
  - 5. Exposed, moving, drive elements shall be protected by metal housing, which shall provide access for lubrication of components.
  - 6. Provide a low oil sensor to prohibit starting of the escalator on automatic operation with low oil in the gearcase.
- G. Head shaft bearings shall be rated with an ABMA L10-life of 200.000 hours.
- H. All exposed gearing, sprockets, and chains shall be covered with guards. Side panels of guards shall be in sections of convenient size and removable for purposes of inspection and maintenance.

## 2.09 CONTROLLER AND WIRING

- A. The escalator control equipment shall contain diagnostic capabilities as required for the ease of complete maintenance. The diagnostic system shall be an integral part of the controller and provide user-friendly interaction between the service person and the controls. All such systems shall be free from decaying circuits that must be periodically reprogrammed by the manufacturer.
- B. The controller shall be mounted in stainless steel, NEMA 4X cabinets with strip heaters and labeled terminal strips. Enclosure shall utilize continuous stainless steel hinge and two-point fastening mechanism.
- C. The main controller shall use a programmable logic controller (PLC) to control and monitor the status of the escalator. The PLC shall be designed to communicate with

escalator parts over an Ethernet port or serial port(s). In addition, it may also have a dedicated serial port for programming or configuring purposes.

- D. The PLC racks shall provide space for two (2) future single-slot modules.
- E. The PLC shall store the last 99 safety device faults, accessible via laptop connection, panel view, or remote communications.
- F. Contractor shall provide a copy of all working programs on approved computer medium as well as a printed program listing.
- G. The controller of an escalator shall contain at least the following devices:
  - 1. Lockable main switch thermal and magnetic motor protection starter for up and down travel, hour counter, auxiliary contractors, phase failure device, phase sequence monitor, and ground fault monitor.
  - 2. The controller cabinet shall contain a permanently mounted full color view panel capable of providing fault and operating data. The indication shall be locked automatically. Reset shall be done by a separate switch installed in the controller. The emergency stop shall not be locked.
  - 3. All terminals shall have identification markings and all cables shall be provided with cable markers.
  - 4. The controller may be equipped a full time, regenerative, VFD drive capable of full speed control for maintenance and future "sleep mode" operation.
  - 5. Relays shall be provided with visual indication that they are energized.
  - 6. Controller shall be capable of operating the escalator in Variable Rated Speed Operation as per ASME A17.1-2010 requirement 6.1.4.1.1 regardless of the ASME A17.1 Code in effect.
  - 7. A non-reset, minimum five-digit, run time meter shall be provided with the controller to measure whole hours escalator is in operation.
- H. Wiring shall be minimum No. 18 AWG stranded, color coded, and permanently identified with embossed tubing sleeves to match controller schematics at all terminations. Wiring shall be low-smoke and halogen-free. A maximum of three wires shall be terminated at any screw type terminal. Wiring jumpers, taps and multiple wire connections shall be located on a terminal; tee taps, wire nuts or mid conductor splices are not permitted. All controls shall operate at 120 Volts or lower, AC or DC. Control power shall be obtained from integral dry type control transformers. Primary and secondary fuses shall be provided with load side indicating neon lamps.
- I. Raceways in truss between components shall use rigid galvanized steel conduit with threaded or compression fittings. When used, flexible raceways shall utilize liquid-tight flexible metal conduit and compression type fittings. Flexible raceways shall not exceed six feet in length. Boxes shall be NEMA 4X stainless steel. Water tight,

gasketed hubs shall be used for all raceway, entries to cabinets, boxes and controller.

1. Wiring external to controller including switches and control wires shall utilize at least No. 18 AWG copper stranded machine tool type, moisture, heat and oil resistant thermoplastic insulated conductors. Terminations at devices and terminals shall utilize insulated type crimp connectors. For all crimped connections, crimper used shall be Panduit CT-550 or equal. Anti-corrosion protection shall be provided for all connectors using Thomas and Betts "KOPR-Shield" CP-16 or equal. Terminals shall be identified with wire numbers that correspond to wiring diagrams. Wiring shall be laced and tied at terminal blocks. Conductors shall be identified with embossed tubing sleeves at each terminal. Terminations shall be made within boxes at terminal strips.
2. All wiring shall be tested by means of 500 Volt megger prior to connection to safety and control devices.
3. Control wiring shall be color coded by function to assist in troubleshooting and maintenance.

J. Main power feed to controller shall be a 480 Volt, three phase, dedicated circuit. If escalator is being installed in an existing facility and existing circuit breaker(s) are insufficient for new escalator, then the Contractor shall furnish and install new, appropriately sized circuit breaker(s). Contractor shall provide the necessary cabling and any conduit modifications from the switchgear cabinet to the new escalator controller at no additional cost to the District. New conduit shall be concealed within structure except as otherwise indicated on the Contract Drawings.

K. Remote Control Inspection Station:

1. Provide a Remote Control Inspection Station consisting of a portable switch box, extension cord, and plug-in cap for each escalator to allow operation of the escalator by remote control during periods of inspection and service.
2. The Remote Control Inspection Station shall include an emergency stop switch (maintained-contact selector switch), and "up" direction push button (momentary contact only when button is held down) and a "down" direction push button (momentary contact) housed in a stainless steel enclosure and connected to a 10 foot "Tyrex" cord (number of conductors as required) with multi-conductor screw cap and matching receptacle, suitable for use in corrosive area.
3. Two receptacles with tethered or hinged weatherproof caps, one at each end of the escalator, shall be provided in the pit area for the attachment of the Remote Control Inspection Control Station. These receptacles shall be of a common ready available national brand manufacture and designed such that the escalator will not initiate normal operation unless caps are in place.
4. When the Remote Control Inspection Station is plugged into either receptacle all normal operating devices, including all regular and automatic control switches, shall become inoperative and full control of the escalator shall be transferred to the Remote Control Inspection Station. The operating speed of the escalator

shall automatically be reduced to the maintenance mode speed. Control shall be returned to the normal operating devices when the Remote Control Inspection Station is removed from the receptacle and the receptacle cap is in-place. All safety devices except missing step devices, handrail speed sensors and speed encoders shall remain effective during the maintenance mode.

L. Fault Indicating Device:

1. Provide a fault indicating device in the front panel of the controller that shall visually indicate and identify the actuation of each and every safety device causing escalator shutdown and shall cause the indication to remain until the fault is cleared by maintenance personnel or automatic reset.
2. Provide an identical display and reset button in the upper right newel of the escalator, or at a location to be determined by the Engineer. The local display shall be concealed behind a lockable door. The type of key will be assigned by the Engineer.
3. The fault indication device shall provide diagnostic capabilities including the following information:
  - a. Historical data storage in ASCII text of at least 100 events that records escalator identification, date, time and cause of any and all escalator stoppages and faults. Historical data shall be printable by downloading to laptop computers.
  - b. Drive motor over temperature.
  - c. Braking distance with date and time stamp for each stoppage, manual or automatic. Measurements shall be expressed in inches and accurate to 0.1 inch.
  - d. Operating status of escalator (ready to run, running, reset required, or maintenance mode).
  - e. Operating direction of escalator.
4. Event data shall be retained if the power to the controller should fail.

M. The Contractor shall provide one notebook style computer and the necessary software to assist in the programming, setup, and troubleshooting of the escalator controller. The computer software shall be able to extract, view, store, and print the event reports from the controller and provide access to any other available trouble shooting information the controller may provide. The computer shall have the latest processor and operating system compatible with the escalator controller and shall have the ability to update all software.

N. Foreign Voltage Relay: Provide one multi-pole, 600 Volt Class for isolation of all foreign voltage conductors entering the controller to safely isolate all electrical sources. Examples of foreign voltages are the fire alarm shutdown, external directional signs, seismic switch, rolling grille, and malfunction alarm to station agent's booth. Coil of relay shall be de-energized when main disconnect is open.



Relay shall be located in separate NEMA 4X stainless steel box and shall be labeled "Foreign Voltage Relay" with an engraved nameplate.

- O. The escalator controller shall interface with the station fire alarm system. In the event of station fire alarm signal, the escalator emergency stop alarm shall be activated for at least 15 but not more than 20 seconds, at which time the power to the driving machine motor shall be interrupted and the brake applied.
  - P. The escalator controller shall interface with the station seismic sensor or a dedicated escalator seismic switch located in machine room, as approved by the engineer. In the event of seismic event, the power to the driving machine motor shall be interrupted and the brake applied immediately and the escalator emergency stop alarm shall be activated immediately and operate for at least 15 seconds.
  - Q. The escalator controller shall interface with the associated, station entrance, security grill where present. Escalator shall shut down when grill is lowered.
  - R. The controller shall provide the necessary relay contacts to control the station ceiling directional signs, including during fire alarm activation.
  - S. The escalator controller shall provide the signal to report any failures or out of service conditions to a District's remote monitoring system. Additional signals shall be provided to indicate operating modes (running up, running down stopped, stopped with a fault) display in the station agent's booth.
1. The escalator controller shall also provide discrete, normally open contacts or dedicated PLC output signals to each of the safety devices within the escalator to interface with the SCADA system. Other safety devices not listed shall be combined with other faults as determined by the Engineer.
    - a. Emergency Stop – Top.
    - b. Emergency Stop – Bottom.
    - c. Handrail Inlet – Top (left and right).
    - d. Handrail Inlet – Bottom (left and right).
    - e. Skirt Switches – Top (left and right).
    - f. Skirt Switches – Bottom (left and right).
    - g. Comb impact – Top (left and right).
    - h. Comb impact – Bottom (left and right).
    - i. Missing Step – Top.
    - j. Missing Step – Bottom.
    - k. Step Sag Switch – Top.
    - l. Step Sag Switch – Bottom.
    - m. Step Upthrust – Left and Right.

- n. Starting Fault – (reverse phasing, anti-reversal switch).
  - o. Brake watchdog (brake pick and brake wear).
  - p. Communication fault.
  - q. Miscellaneous – Pit Switches, broken drive chain switch, overload, governor.
  - r. Carriage tension switch – Left and Right.
  - s. Handrail speed – Left and Right.
  - t. External Safeties – Fire alarm shutdown.
  - u. “Mechanic On-Site” switch. This switch is activated by opening Newel display swing door, or the controller door, or when controller is on “Manual”. When activated, the event is automatically entered into controller history log, and into BART SCADA system.
  - v. Running up. This signal is intended for display in the station agent’s booth.
  - w. Running down. This signal is intended for display in the station agent’s booth.
  - x. Stop. This signal is intended for display in the station agent’s booth.
  - y. Stop with a fault. This signal is intended for display in the station agent’s booth.
2. Besides an Ethernet port (if any, as described in 2.09-C) to control/monitor escalator devices, the programmable logic controller (PLC) shall have another Ethernet port to communicate with the SCADA and NTP server. The PLC shall support automation protocols such as Distributed Network Protocol over TCP (currently DNP3), Ethernet/IP (ODVA CIP), Modbus/TCP, or BART Communication Protocol (BCP).
  3. Alternatively, instead of the direct Ethernet connection to SCADA as mentioned above, contractor may provide dry contacts to an Ethernet i/o module such as AB FlexIO or PointIO. The Ethernet i/o module uses an automation protocol over Ethernet such as DNP3, CIP, Modbus/TCP, or BCP to communicate with SCADA/station PLC. BART SCADA System communicates with the escalator controller through a Rockwell Automatic PLC/PAC or a Schweitzer Engineer lab (SEL) data concentrator.
  4. A separate Ethernet communications path will be provided from the train control room BARTnet interface cabinet to each escalator controller to provide the ability to time synchronize the controller with BART Network Time service (Network Time Protocol – NTP). An Ethernet connection on the escalator controller will be provided. The NTP server service to drive this connection will be BART’s responsibility. The escalator controller will provide an NTP software client compatible with NTP Version 3 Specification (RFC 1305) and be capable of operating in NTP broadcast-client mode.
- T. All controller devices shall be labeled corresponding with identification shown on wiring diagrams. Labeling medium shall be either indelible stamped ink or engraved labels.

- U. All switches and indications mounted on the controller enclosure's exterior shall be labeled with laminated engraved white on black five sixteenths of an inch character permanently mounted nameplates.
- V. Section 20 70 26, Common Materials and Methods for Electrical Systems, shall govern all electrical materials and methods not covered in this Section.
- W. Controller shall have circuitry terminals to disable any and all speed and detector sensors for testing and trouble shooting.

## **2.10 SAFETY DEVICES AND SWITCHES**

- A. Key Switches:
  - 1. Escalators shall have key operated switches, accessible at both upper and lower landings, located on the exterior deck above the newel base. Alternate locations may be used subject to approval by the Engineer.
  - 2. Each keyed switch shall be clearly and permanently labeled on engraved metal plates, including ON-OFF and UP-DOWN selection.
  - 3. Keys and cylinders shall be Designated Matching Product "Allen Bradley" cylinders keyed to D018 Allen Bradley key with keyways. The UP-DOWN key switch shall be model #800T-J631A and the ON-OFF key switch shall be Model #800T-H33B. The Engineer will furnish Type Tumbler information upon request.
    - a. Display panel swinging door lock shall be:
      - 1) Best IC7M1 – 626A A1 core.
      - 2) Best 1A1M1 – KS473-KS800 core key.
      - 3) Best 1E7D4 – C228-RP3-626 cylinder key A1 core.
- B. Key Switch Operation
  - 1. Both ON-OFF key switches must be in the ON position in order to start the unit. When either one (or both) are in the OFF position, the unit shall not run, either in automatic or maintenance mode.
  - 2. If both ON-OFF switches are in the ON position, and either UP-DOWN key switch station is actuated for a minimum of two seconds in the desired direction, it operates the unit on automatic mode in that direction. This feature is disabled during maintenance mode.
  - 3. Once the unit is running in the automatic mode per the UP-DOWN direction selection, when either ON-OFF key switch actuated to the OFF position, it stops the unit immediately with the brake, as any other safety device will stop the unit.
  - 4. The change of direction shall only be possible after the escalator is stopped.
  - 5. If the UP-DOWN directional key switch is held in either direction without interruption for 10 seconds, the unit will stop with a stuck key switch fault and a

reset is required. This includes if the unit is running up and the down input goes high for 10 seconds (or the opposite), a stuck key switch fault appears and requires a reset.

C. Safety Devices:

1. Provide all a safety devices required by applicable codes and publications referenced here in on each escalator.
2. Safety devices, depending upon interruption of electric circuit for their operation, shall be interlocked to remove the electric power supply to the motor and shall apply the brakes to bring the escalator to a smooth, safe stop in the original direction of travel.
3. Safety devices shall be mounted in locations accessible for maintenance within escalators, and these devices shall be designed for ease of adjustment or reset. Devices shall be so located that their operation will not be affected by moisture or debris.
4. If escalators are equipped with a braking system dependent upon activation of springs, then the springs shall be of a guidance compression type. The use of weights or self-excitation of the brake release shall not be allowed.
5. Disconnect switches capable of being locked in the "off" position shall be provided at the upper and lower pit of each escalator to prevent the starting of the escalator from any other location.
6. At each escalator, Contractor shall provide the safety devices that shall interrupt electric power within escalator, and automatically apply brakes and bring escalator to a smooth stop in the original direction of travel in accordance with ASME 17.1.
7. Emergency Stop Button:
  - a. Emergency stop button shall be provided in accordance with ASME 17.1.
  - b. Stop buttons shall be watertight, momentary contact push buttons, stet, shall bear the label of a national recognized testing laboratory, and be constructed in accordance with UL Standards.
8. A switch shall prevent operation of the escalator if any part of the floor plate is not in place. This shall not be a manual reset device.

## 2.11 BRAKES

- A. Each escalator at a minimum shall be provided with the following brakes for stopping and locking of movable drive components:
1. Motor brake shall be located on the motor shaft. Brake shall safely stop escalator upon activation of normal stop control, local or remote emergency stop buttons, activation of any safety device, or upon loss of power.

2. Service brake shall be located on the main drive shaft. Brake shall mechanically lock linkages to truss when repair work is being performed within truss.

**B. Operational Sequence**

1. Driving-Machine Brake shall be provided in accordance with ASME A17.1.
  - a. Brake shall be mechanically or magnetically applied (fail safe) and electrically released. Brake shall be capable of stopping and holding an escalator at the Machinery Rated Load.
  - b. The brake shall be designed per prevailing version of ASME A17.1 at time of contract signing. Stops shall be gradual and not abrupt.
  - c. Deceleration shall be smooth, gradual, and with no sudden stops.
  - d. There shall be no time delay designed into the application of the brake.
  - e. Design of brake shall provide ease of access to brake equipment for inspection maintenance, and replacement.
  - f. The brake operating temperature shall not exceed 195 degrees Fahrenheit above ambient. Temperature and wear monitors shall be provided, and if brake lining becomes insufficient for safe usage, restart of escalator shall be prevented and reported as a brake wear fault. When energized and released, a contact closure indication shall be provided to the controller.
  - g. The brake coil shall be insulated to Class F.
  - h. Brake assembly shall be protected from falling water and debris by a removable cover. Cover shall not be higher than 6 inches above brake assembly.
2. Service Brake
  - a. Brake shall be manually applied and mechanically engaged to prevent movement of the stepband, while escalator is disconnected from its power supply.
  - b. An electrical interlock shall be provided that shall prevent escalator drive motors from starting while service brake is engaged.

**2.12 STEPS**

- A. Provide a minimum of three flat steps at upper and lower ends within one-sixteenth inch of each other as defined in ASME A17.7.
- B. The steps shall be one-piece die cast aluminum with no more than 0.3 percent copper content designed to carry a load of 320 pounds per step under eccentric loading conditions with a maximum distortion of 5/32 of an inch with an ultimate strength safety factor of eight (8).
- C. The step roller wheels shall be designed for quiet operation and shall be a type that will assure rotation and prevent flat spots. They shall be mounted to prevent tilting

and the rocking of the steps in excess of one-sixteenths inch maximum at the step's extremity. They shall be provided with sealed bearings. Step roller wheels shall be tired with synthetic composition materials. Bearings shall have an ABMA median life (L50) 200,000 hours calculated in accordance with ABMA Standard 9 or 11. Step roller outer diameter shall be minimum four inches.

- D. The design of the steps and their various attachments shall permit step removal without disturbing the balustrades or dismantling any part of the chains. Lock washers shall be provided on all tap bolts, and lock washers and lock nuts or an approved equal shall be on all through bolts.

## **2.13 STEP DEMARCATION LIGHTS**

- A. Provide step demarcation lights at the top and bottom of each escalator not to exceed 16 inches from comb plate. Lights shall consist of two, 120vac, five Watt minimum LED light fixtures and waterproof enclosure at each end of the escalator that shall be installed directly below the track system. The fixtures shall be provided with green LED lamps with a color temperature of 5000 Kelvin, which light up the full width of the step separation.
- B. Provide redundant strip LED lighting at each landing, activated whenever escalator is in operation.

## **2.14 STEP CHAINS**

- A. The step chains shall be of the endless type, one located on each side of the steps. Step chains shall be precision roller-fishplate chains of high grade, heat treated steel, and specifically designed for escalator applications. The pins, bushings, and rollers shall be hardened and ground. Pins shall be interference-fit into the outer links (except for one side of connecting link with detachable side plate) to prevent movement between link plates and pin. Retention of pins to side plates shall be by either riveted (deformed) pin ends, or full circle snap rings except for detachable side plate. Riveted (deformed) pin ends are preferred. The single detachable side plate on the connecting link shall be interference-fit into inner links to prevent movement between link plates and bushing. No split bushings shall be allowed. Master links shall be retained with full-circle snap rings requiring special pliers for removal, per BART Engineering Specifications. BA-ENG/ES 02/EM025.
- B. Materials and manufacturing methods employed shall be designed to provide long (seven to 10 years) service life, under heavy traffic exposure to weather, corrosive fluids, and dusty conditions. Actual warranty requirements shall be per General and Special Provisions of the Contract.
- C. A shielding device shall be provided to protect the chain track guides, and rollers against water, debris, and dirt.
- D. The chains shall be designed for 320 pounds per step load:
  - 1. The step chain and chain pins pressure at engaging points shall be less than 4350 per square inch based on the machine rated load.

2. The breaking factor of safety of a step chain shall be at least six (6) based on the machinery-rated load.
- E. Pins shall comply with the following requirements:
1. Surface hardness of the pin OD and bushing ID shall be 60-64 HRC, Knoop 500 gram micro-hardness shall be 732-822 over a case depth of 0.01 inch below the finish ground surface per ASTM E 384.
  2. Tensile strength: 1200 Newtons per square millimeter.
  3. Diameter: One inch minimum.
  4. Pin center to pin center length shall not exceed 133 millimeters.
  5. Pin outer surface and bushing inner surface shall be finish-ground after hardening. All parts shall be completely de-burred and ready for installation.
- F. Matched lengths of chain pairs shall have their length difference documented, and certificates shall be shipped in the box with each pair.
- G. Provide minimum four-inch diameter synthetic composition rollers, to meet BART Engineering Specifications, with sealed ball bearing at each step to support the chain and leading edge of the step.
- H. Provide three extra links per each escalator step chain assembly or step chain section to permit the selection of a link by the Engineer for testing. The Engineer may randomly select a link from anywhere along the length of the step chain. Contractor is responsible for testing by independent lab subject to approval by the Engineer specified under Article 3.03, Field Quality Control, herein.

## **2.15 ROLLERS**

- A. Roller centers shall be made of cast aluminum alloy or bar stock aluminum alloy 6061-T6. The roller center shall incorporate positive bearing retention to ensure that the bearing is retained without movement in the roller center for the life of the bearing.
- B. The bearing shall be full-contact, double sealed ball bearings, SKF, NTN, SNR, or equal.
- C. Bearings shall be pre-lubricated by the bearing manufacturer for the life of the bearing.
- D. Bearing manufacturer shall be ISO 9000 series certified.
- E. The wheels, hubs, and bearings shall an L10 rating of 100,000 hours.

## **2.16 COMB TEETH SEGMENT**

- A. The comb teeth shall be epoxy powder coated safety yellow aluminum, with comb teeth so arranged that the cleats of the step treads will pass between them. The comb teeth shall be made in sections so that any damaged or worn section can be replaced without disturbing the balance of comb. The comb teeth shall be formed to correspond to the form of the treads and maintain a uniform side clearance. Comb plate fasteners shall have securing threads of same material as the fasteners to prevent bonding. Inserts are permitted if necessary. All fasteners shall utilize an Allen wrench to remove/replace. Provisions for lateral and vertical adjustment shall be provided so that cleats of steps tread pass between comb teeth with minimum clearance.

## **2.17 HANDRAILS AND HANDRAIL DRIVE SYSTEMS**

- A. Traction drive handrail system shall maximize the contact around the upper newel drive wheel and provide a minimum positive drive contact of 48 inches. Handrails shall be firmly engaged by the drive and shall not have any slippage during start-up or running in either direction. No back-bending of the handrail at any point throughout the entire drive path is strongly preferred.
- B. Handrails shall receive their motion from main escalator drive through direct gearing and drive shaft and/or drive chains minimum, so that handrail and steps operate at the same speed in each direction of travel. Handrail drive chains shall be minimum ANSI No. 80 up to 18 feet rise, and minimum ANSI No. 100 for >18 feet rise. Driving and guiding wheels shall have a groove to accept the wedge on the underside of the handrail where applicable.
- C. Handrail drive system shall be designed to permit installation of replacement handrails without field splicing.
- D. Provide convenient way of adjusting handrail tension and drive chain tension.
- E. Newels meeting the following requirements shall be provided:
  - 1. Newels shall be designed and constructed so that handrail shall return into newel end at a point inconspicuous and difficult for passengers to reach.
  - 2. Newel sheaves shall be provided at upper and lower newels. Newel wheels shall have minimum two-inch shaft with extra heavy-duty hubs and bearings, four-inch O.D. tapered roller one-and-a-half-inch thick sealed cup and cone bearings.
  - 3. Handrails, handrail drive system, and guides shall be so designed and installed that handrail cannot be thrown off or disengaged while running, and special design attention shall be given to area where handrail passes from drive system to guides. Stationary guides at the newel return shall not be considered acceptable. A method of guiding the handrail and reducing friction by a large diameter newel wheel shall be provided.



4. Newel sheaves shall have sealed bearings that have provision for retention of lubricant to ensure satisfactory lubrication and operation. Additional lubrication shall not be required.
  5. Friction drive wheels and idlers shall be designed and positioned so that lubricant cannot reach surface of handrail. Marking and spotting of handrail by drive equipment shall not be permitted.
- F. Handrail color shall be black and shall be constructed of laminated, steel, wire mesh, or steel cable reinforced, flexible elastomer material vulcanized into an integral, non-separating, seamless, smooth handrail resistant to environmental conditions. A "V" shaped underside design shall be used, providing a more positive drive. No cotton fabric shall be used. Black color pigment shall be integrated into the polymer; painting shall not be acceptable.
- G. The elastomer shall be molded and vulcanized into the carcass assembly. The adhesive bonding of the laminated components shall be scale 4 as defined in ASTM D-2630. The elastomer shall be composed of high quality chlorosulfonated polyethylene, Dupont Hypalon, or equal. The compound is to have an ultimate tensile strength of 1500 pounds per square inch, in accordance with ASTM D412. The interior polymer shall be a thermally stable monosulfide crosslink. All formulations are to contain ultraviolet and ozone inhibitors for resistance to outdoor aging. When tested in accordance with ASTM D1149 there shall be no cracking of the surface visible under 2X magnification. The surface of the cast elastomer shall be smooth and free of irregularities cause from splicing or mold section marks protruding more than one-sixteenth inch (0.0625 inch). The composite shall be able to withstand elongation equal to 300 percent at break per ASTM D412.
- H. Hand rail reinforcing fibers shall be encased in adhesive between the first and second layers to act as tension members.
- I. The slider fabric or wear ply shall be constructed of synthetic materials which will not swell when moist.
- J. The handrail shall be capable of being bent around a 19 inch diameter sheave at 32 degrees Fahrenheit without visible evidence of buckling, cracking, delaminating, or crazing.
- K. Handrail guides shall be continuous on exposed portion of handrails, constructed of material which shall not corrode or pit and shall have a polished, permanent smooth finish to minimize frictional wear to any surface of handrail. On the unexposed portion, guiding shall be by adjustable rollers having sealed bearings, and set in a way so as not to cause wear on the handrail. Gaps between guide sections shall be less than or equal to one-eighth inch and shall be level.

## **2.18 LANDING PLATES**

- A. Provide aluminum landing plates designed to be supported on truss heads and covering the entire area of the landing within the outline of the truss. Landing plates of adjacent stairs or escalators that jointly cover the same pit area shall match the landing plates of the new escalator.

- B. Landing plates shall be extruded from die cast aluminum in a ribbed pattern transverse to the escalator axis. Ribs shall be designed to provide maximum traction, and shall be finished in the same manner as the comb plates. They shall have exposed portions constructed of material and finish to harmonize with steps and comb plates.
- C. Landing plates shall be reinforced, as necessary, to be rigid and able to withstand a live load of 250 pounds per square foot, with a maximum deflection (in inches) equal to  $L/360$ , where L is equal to the largest span (in inches) between two support members of the landing plates. Landing plates shall experience zero permanent deflection.
- D. Landing plates shall be pivoted to swing upward to a vertical position, or plates may be made in removable sections to provide access to the pit. Plates shall be removed either by removable T-handle lifts or other approved methods. Plates shall not exceed 40 pounds each.
- E. Means shall be provided to secure the landing plates in the closed position. All locking means such as bolts or screws shall be captive.

## 2.19 BALUSTRADES

- A. Balustrade panels shall be a minimum of 14 gage stainless steel, Type 316. Refer to Section 2.03.A.2 for finish. Backing panels, where used, shall be noncombustible and subject to Engineer's approval. Stiffeners, brackets, attachment angles and other concealed ferrous metal framework shall be galvanized or constructed of equivalent, corrosion-resistant materials.
- B. Balustrade panels shall be attached by means that allow easy assembly and disassembly without the removal of trim, safety brushes, or other flashing.
- C. Panels shall be constructed, when practical, in equal lengths for interchangeability.
- D. Panels shall have edges sealed against moisture.
- E. Panels shall be sized so that no more than one person shall be required to remove a panel. Panels shall be designed to be removed without the aid of special handling equipment other than suction cups. Horizontal and transitional panels shall not exceed 35 pounds in weight. Incline panels shall not exceed 45 pounds.
- F. Panels shall be securely attached and also permit easy removal for inspection and maintenance.
- G. When framework to which panels are fastened is less than one fourth inch thick, steel backup plates with a minimum one fourth of an inch thickness shall be added which have tapped holes or clearance holes where necessary. Panels shall be attached so as to not affect adjacent panels.

## **2.20 SKIRT PANELS**

- A. Skirt panels shall be stainless steel, solid construction, minimum 11 gage thickness, and shall conform to ASME A17.1.
- B. The height of the skirt panel above the tread nose line shall be at least one and a half inches measured vertically. The height of the skirt panel below the intersection of the two steps along the incline shall be at least one inch measured vertically.
- C. Skirt panels shall deflect not more than one sixteenth of an inch under a force of 150 pounds force.
- D. Skirt panels shall have rounded smooth joints and seams.
- E. Stiffeners, brackets, attachment angles and other concealed ferrous metal framework shall be galvanized or constructed of equivalent, corrosion-resistant materials.
- F. Skirt Panel Fastening Requirements: Panels shall be fastened to their respective supports or mating portions with no exposed fasteners from the side adjacent to the steps.
- G. When framework to which panels are fastened is less than one fourth inch thick, steel backup plates with a minimum one fourth of an inch thickness shall be added which have tapped holes or clearance holes where necessary.
- H. Skirt panels shall be aligned and adjusted so as to achieve the step/skirt performance index as defined in ASME A17.1 Rule 6.1.3.3.9.
- I. Provide black color skirt deflector brushes in accordance with ASME A17.1 Rule 6.1.3.3.10 along the skirt panels to keep people's feet away from the skirt panels.

## **2.21 DECK COVERS AND MOLDINGS**

- A. Deck covers and molding shall be a minimum of 14 gage, stainless steel, Type 316. Refer to Section 2.03.A.2 for finish.
- B. Surface joints in the deck covers shall be metal-to-metal with gasketed joints below the surface to provide a waterproof seal. Where concealed fastenings cannot be used, exposed fastenings shall be countersunk flush, tamper-proof, and finished to match the adjacent materials.
- C. Decking of the escalators shall be designed to support a live load of 175 pounds per square foot, without surface deflection.
- D. Paneling, decking, and other enclosures shall be supported on steel framework. Deck covers shall be attached to the truss framework without the use of exposed screws. Decking shall be sloped to prevent ponding of water anywhere.
- E. Baggage stops shall be provided on any decking surface exceeding four inches in width per code. Each stop shall be at least 1.875 inches in diameter, two inches high,

made of stainless steel and fastened securely using two fasteners to prevent turning and loosening. The distance between stops shall be no less than seven feet. Provide top and bottom terminal baggage stops which shall have a three eighths inch diameter horizontal hole to permit locking of maintenance barricades.

## **2.22 REMOTE MONITORING SYSTEM**

- A. The Contractor shall provide the signals to report any failures or out of service conditions to the existing District's Escalator/Elevator Remote Monitoring System. The existing EERMS was developed and is owned by the District. The EERMS communicates with the escalator controller through the Communications Interface Cabinet.
- B. Fault and Event List: The controller shall provide the following signals to the KOYO modules. These signals shall be reported instantaneously as the controller responds to the initial signal within the elevator system. In the event a monitored condition cannot be determined directly from the controller, the Contractor shall provide the necessary sensor device. The following safety circuits and conditions ("Events List") shall be established for reporting.
  - 1. Door Lock.
  - 2. Loss of Power.
  - 3. Safety Circuit.
  - 4. Emergency Stop Button.
  - 5. Emergency Service (Fire Alarm or Earthquake).
  - 6. Car at Top Landing.
  - 7. Car at Middle Landing (if applicable).
  - 8. Car at Bottom Landing.
  - 9. In service (ISV and ISRT signals in parallel).
  - 10. Spare.
  - 11. Spare.
  - 12. Car Shutdown by Agent.
  - 13. Car Occupied.
  - 14. Mechanic On-Site (door switch and ISV signal).

## **2.23 ENERGY EFFICIENT MOTOR CONTROLLER**

- A. Provide a motor controller that monitors and varies the current and voltage waveforms to achieve power savings when the escalators are under light load.

## **2.24 MISCELLANEOUS**

- A. Contractor shall provide at least one folding step inside the top and bottom escalator pits to assist the mechanics entering and exiting the escalator pits. The steps shall be painted bright yellow and labeled with black lettering reading "STEP".
- B. Duplex receptacles with GFI circuits shall be provided in the upper and lower pits and in the escalator machine room. Receptacles shall be industrial grade 120 Volt, 20 Amp receptacles housed in stainless boxes and covers with watertight snap covers.
- C. Pit lights shall be installed in upper and lower pits. Fixtures shall be equipped with polycarbonate clear globe, protective metal grille and 120 Volt, 5000 lumen lamps.

# **PART 3 – EXECUTION**

## **3.01 PREPARATION**

- A. Verify dimensions in the field before proceeding with the work. Verify the following to be acceptable for installation of escalators:
  - 1. Wellways size, location and ancillary installations.
  - 2. Truss supports.
  - 3. Electrical conduits and wiring.
- B. Correct unsatisfactory conditions prior to proceeding with the work. Where escalator is being installed in an existing wellway, notify the Engineer immediately if unsatisfactory conditions exist, and do not begin installation until non-compliant conditions have been corrected.

## **3.02 INSTALLATION**

- A. General: Install in accordance with the requirements of the manufacturer and regulatory agencies and as specified herein. Lubricate all equipment per manufacturer's instructions. Adjust brakes, controllers, switches, handrail tension and safety devices to achieve required performance.
- B. Adjust skirt panels plumb with a maximum running clearance gap of not more than one-eighth inch at any point between steps and skirt panels.

- C. Galvanized surfaces that have become damaged from welding, handling, or installation shall be repaired immediately after installation with galvanizing repair material in accordance with ASTM A780.
- D. Truss field splices shall be rigid, non-deforming, and shall maintain the truss alignment and structural integrity.

### **3.03 FIELD QUALITY CONTROL**

- A. General
  - 1. Contractor shall notify the Engineer seven Days prior to each scheduled test. Contractor shall perform testing in the presence of the Engineer and appropriate State and other jurisdictional authorities.
  - 2. Contractor shall notify Engineer, a minimum of seven Days in advance of final acceptance tests.
  - 3. Regulatory Agencies Inspection: Upon completion of escalators, the Contractor shall provide instruments, weights and personnel to conduct tests required by regulatory agencies and the Contract Documents. The Contractor shall submit a complete report describing the results of the tests, to the Engineer for approval.
- B. Step Chain Testing: Step Chain Testing: Step chain links shall be tested by an independent laboratory approved by the District, paid by Contractor, to demonstrate compliance with the Contract Specifications and the escalator manufacturer's step chain specifications. Links to be tested will be selected by the Engineer. If links fail to comply with the specifications, step chains will be rejected and additional test shall be required on the replacement step chains at no additional cost to the District. All tests shall be witnessed by the District and documented by the Contractor. Test records shall be submitted to the District for approval.
- C. Acceptance Testing Requirement
  - 1. Testing shall be performed after installation and before substantial acceptance of the escalator and the escalator is placed in service. All tests shall be witnessed by the District and documented by the Contractor. Test records shall be submitted to the District for approval.
  - 2. Contractor shall perform the following tests on each escalator without load:
    - a. All safety devices and switches shall be operated to verify proper shutdown of escalator in both directions.
    - b. All safety devices reported by the remote monitoring system shall be tested to verify proper reporting to the local fault indicators and Central Monitoring system.
    - c. A comb plate impact test shall be performed at each landing to verify both vertical and horizontal force activation.

- d. A skirt deflection and test friction shall be performed to verify compliance with ASME A17.1.
  - e. Contractor shall demonstrate the escalator is operating at the proper speed in both the normal and maintenance modes of operation.
  - f. Push buttons, starting switches, starters, relays, interlocks, and controls required in connection with work: Inspect and test to prove that complete escalator functions properly under all conditions of operations within limits specified.
  - g. Conductors for power and control wiring before connected: Test for functionality, continuity, isolation and grounding.
  - h. Escalator shall produce no noise louder than sixty-five (65) decibels measured at a distance of 48 inches above the floor or stair level at the entrance combs at both ends with the escalator operating normally, either free-running or under load. Ambient noise level shall not exceed 55 decibels while performing the test.
3. A full load test shall be performed for each escalator prior to acceptance, to demonstrate braking operation as described herein.
- a. Escalator shall be loaded with test weights, as required to meet the Machinery Rated Load. Weights shall be distributed along the escalator as necessary to provide a sufficient number of empty steps to permit the escalator to stop without any test weight hitting the comb plates. Detail of loading to be approved by the Engineer. Load weights shall be supplied by the Contractor.
  - b. Both static and dynamic tests shall be performed.
  - c. Braking performance shall be observed and recorded over five consecutive stops for zero percent, 25 percent, 50 percent, 75 percent and 100 percent of the Machinery Rated Load by operating escalators in the down direction, and for zero percent, 25 percent and 50 percent of the Machinery rated Load by operating the escalator in the up direction.
  - d. Motor current readings shall be taken and recorded during each condition. Deceleration and stopping distance of the escalator shall be measured and recorded for each test. Deceleration shall be measured using a calibrated accelerometer or other means approved by the Engineer. A report with complete documentation and records for each test shall be submitted to the Engineer for approval within seven Days of the completion of the tests.
- D. Correction: Make corrections to defects or discrepancies at no cost to the District. Should discrepancies be such that re-examination and retesting is required, all costs, including those of the District's representative, shall be paid for by the Contractor.

### **3.04 REGULATORY AGENCIES INSPECTION:**

- A. Upon successful completion of escalator testing, the Contractor shall schedule the necessary inspections with the appropriate State Agency for all necessary permits as specified in Section 1.12 Permits.

- B. Contractor shall facilitate the regulatory agencies inspection in the presence of the Engineer.
- C. The Contractor shall provide instruments, weights, and personnel to conduct any tests required by regulatory agencies.
- D. The Contractor shall obtain evidence of permit to operate from the State Agency to the Engineer.

### **3.05 TRAINING**

- A. Training Program: The Contractor shall provide a program to train the District's operations, maintenance and training personnel in details of the escalator system as required to enable the District to operate, service and maintain this system such that this system will perform and continue to perform in accordance with the requirements of this Contract. In regard to work of this Section, these provisions supersede Section 01 79 00, Demonstration and Training.
  - 1. The Training Program shall include formal and informal instruction, as appropriate, and any models, mockups, documentation, and aids to carry out the program.
  - 2. Materials used in the Training Program shall be of durable construction and shall become the property of the District.
  - 3. Assumptions:
    - a. The Contractor shall assume that the personnel to be trained have only the basic skills pertinent to their craft as outlined in the District's job descriptions for the involved personnel.
    - b. The Contractor shall assume that the District personnel to be trained by the training program have no knowledge of features of the equipment or systems to be taught.
  - 4. Training Program Plan: The Training Program Plan shall be submitted within 90 Days of the Notice to Proceed and shall contain, as a minimum, the following data:
    - a. A flow diagram indicating the logical progression of training to be conducted;
    - b. A description of each course, including the number, description and duration for each lesson in the course.
    - c. Resumes showing the qualifications of the proposed instructors;
    - d. A list of all subcontractors or other equipment manufacturers to be used in the training program and a description of their responsibilities;
- B. General: The training shall be provided to the District personnel with the operating procedures necessary to operate the systems provided as an integrated entity. The courses shall include the following training:



1. Classroom training shall give course participants an understanding of the overall system operation.
  2. Hands-on training shall give course participants actual maintenance experience.
- C. Courses: Training shall consist of two courses:
1. Escalator Operations Course:
    - a. The Escalator Operations Course shall train the District's Station Agents and Station Agents Trainers in the operation of the escalators.
    - b. The course shall teach how to start, stop, and change the direction of the escalators. The course shall provide a description of the Diagnostic Panel and explain:
      - 1) How to clear simple fault of temporary nature;
      - 2) The conditions under which the station agent may restart the escalator; and,
      - 3) The conditions under which the station agent may not restart the escalator and should request service from maintenance workers.
    - c. The course duration shall be at least one-half hour.
    - d. The class size will be up to six participants per session.
    - e. The course shall be presented four times; two times during day shift and two times during swing shift.
    - f. Each session shall include specific characteristics of each escalator in the group, if any.
    - g. Training shall be conducted within 30 Days prior to the anticipated date of escalator in service.
  2. Escalator System Maintenance Course:
    - a. The Escalator System Maintenance Course shall provide the District's maintenance workers and trainers with detail knowledge of and hands-on experience with the system functional capabilities and overall operation in order to properly troubleshoot and maintain escalators. The course shall provide participants with a working knowledge of the system equipment and its operation, interfaces, and use of test equipment for diagnosing troubles.
    - b. The course shall provide theoretical background and hands-on experience in troubleshooting and repair procedures to permit participants to locate and repair system faults in a timely manner. Course shall include emergency provisions, including emergency access and procedures to be followed at time of failure in operation and other building emergencies. Train personnel in the procedures to be followed in checking the source of operation failure or malfunction. Operation of diagnostic equipment shall be explained.
    - c. The course shall utilize the complete Operation and Maintenance Manual.

- d. The course shall utilize actual hardware and photographs taken during the manufacturing process wherever possible. Actual hardware used for training must pass re-inspection and acceptance testing prior to being placed in service.
  - e. The course shall consist of a minimum of 16 hours of classroom training and 24 hours of hands-on in the field training. The training shall not exceed eight hours per day.
  - f. The classroom course shall be presented a total of two times and the field training course shall be presented a total of four times. The Contractor shall present the sessions within 30 Days prior to the end of the Maintenance Period.
  - g. The class size will be up to 20 participants per classroom session and up to 10 participants in the field sessions.
- D. Training Location and Classrooms: All training courses shall be conducted in facilities provided by the District. The facilities will be equipped with tables, chairs, and one cabinet with lock hasp. The Contractor shall provide video players and projectors as required.
- E. Instructors: Contractor shall provide qualified instructors. The instructors shall have previous formal classroom instruction training and relevant experience with the provided systems equipment in an operating environment.
  - 1. Classes and instructions shall be presented in person by the instructor.
  - 2. When prerecorded lectures are part of a training course, the instructor shall supplement the recorded material.
  - 3. Instructors shall demonstrate a complete and thorough technical knowledge of the material being covered in the course. These instructors shall be thoroughly familiar with handbooks, guides, tools, test equipment, and other aids used in troubleshooting and repairing the equipment.
- F. Training Reports: A grading system shall be established by the Contractor and approved by the Engineer to report the progress of each trainee during a course. Grading shall be kept strictly confidential and furnished only to personnel in the District that are designated by the Engineer. The grading system shall identify any requirements for further training for each participant.
- G. Training Manuals and Equipment: The Contractor shall prepare training manuals to supplement the Operation and Maintenance Manuals and submit them to the Engineer for review and approval at least 90 Days prior to the start of classroom instruction. The training manuals shall be prepared specifically for use as training aids. The Operation and Maintenance Manuals shall be the primary text.
  - 1. Each course participant shall receive copies of the Operation and Maintenance Manual, Training Manuals, and other pertinent material prior to the commencement of all courses.

2. The Contractor shall provide the master and two additional copies of all Training Manuals and materials as reference documentation.
3. Upon completion of each course, Instructor's Guides, Operation and Maintenance Manuals, Training Manuals, and Training Aids shall become the property of the District. Throughout the Contract and warranty periods, it shall be the responsibility of the Contractor to supply the District with all changes and revisions to the Training Manuals and other documentation.
4. The District reserves the right to copy all training materials and aids for use in the District conducted training courses.
5. The Contractor shall provide all special tools, equipment, training aids, and any other materials required to train course participants. The number of special tools and other training equipment shall be adequate for the number of participants attending the course.
6. The District will provide the Contractor written comments on the Training, Training Manuals and equipment based upon the first sessions. The Contractor shall incorporate the comments and resubmit the documents 60 Days prior to the end of training.

H. Videotaping:

1. Provide video training tape(s) covering complete troubleshooting of escalator drive/brake/fault finder system.
2. In addition, the Contractor may utilize prerecorded lectures as supplementary training material. These shall not serve as a replacement for a classroom instructor or as the primary training vehicle.
3. The Contractor shall provide such videotapes to the District for retention and playback by the District's Instructors as reference documentation.
4. The District shall have the right to videotape training courses presented by the Contractor. The District shall also have the right to use these videotapes to train personnel in the future.

I. Final Deliverables. The final deliverables consist of:

1. Updated and corrected Instructor Guides, Training Manuals and attachments as specified.
2. Sets of participant's materials, 30 Days prior to commencement of training. Quantity of materials per class size specified herein.
3. Any models, mockups, simulations, or other materials that are not supplied elsewhere in this Contract and that are needed to stage the training program.

**3.06 CLEANUP DURING CONSTRUCTION**

- A. The Contractor shall keep escalator area and the space allocated to the Contractor's work in a neat and orderly condition. The tracks shall be kept clean of debris and metal shavings.
- B. The Contractor shall keep any adjacent stairways or escalators clear from debris and provide a safe condition for the public.

**3.07 FINAL CLEANING OF FACILITIES**

- A. Refer to Section 01 74 14, Cleaning. Prior to final inspection by the Engineer, and after each escalator's work is substantially complete, thoroughly clean facilities utilizing professional building cleaners where appropriate.

**END OF SECTION 14 31 00**